

**REVERSE IMPORTING AND ASYMMETRIC TRADE
AND FDI: A Networks Explanation**

by

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Reverse Importing and Asymmetric Trade and FDI: A Networks Explanation

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Abstract

This paper considers the impact of business and social networks on international trade and foreign direct investment (FDI). I propose that differences in the strength of network effects across countries can produce asymmetric trade and investment flows that may lead to trade friction. This proposition is examined using a model of multi-product producers of a differentiated product. A firm from a country with strong network effects has a cost advantage in selling to buyers from its own country. This advantage results in lower inward FDI, lower total imports but larger volumes of reverse imports (i.e., imports from overseas affiliates of that country's own firms) into the country with strong network effects. The model's predictions match observed asymmetric trade and investment flows that sometimes lead to US-Japan trade friction in industries such as automobiles.

Key words: Multinational corporations, Intra-industry Trade, Foreign Direct Investment, Reverse Imports, Networks

JEL classification: F23, F12

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1. Introduction

The importance of business and social networks for international trade has caught the attention of economists in recent years.¹ In an international environment where contracts are not always enforceable and product information is imperfect, relationships between buyers and sellers matter. In some countries and cultures, they seem to matter more than in others. Japanese *keiretsu* and overseas Chinese networks are often cited as examples of networks that affect international trade.² This paper proposes that networks affect not only trade but also foreign direct investment (FDI) and they can help to explain bilateral trade friction. Differences in network effects across countries can produce asymmetric trade and investment outcomes that may lead to trade friction. A country with particularly strong network effects, such as Japan, may have lower inflows of both FDI and imports, and imports may include large amounts of reverse imports (i.e., imports from overseas affiliates of that country's own firms). These low inflows of FDI and imports may be inappropriately attributed to high market barriers rather than to strong network effects.³

Several empirical papers have confirmed that buyer-seller networks influence international trade. Gould (1994), Head and Ries (1998), and Rauch and Trindade (1999) demonstrate the importance of network effects by examining the influence of immigrants on international trade. Immigrants provide information to associates in their countries of origin regarding products currently supplied and demanded in their new location. They have a statistically significant positive effect on bilateral trade between their countries of emigration and immigration. Rauch (1999) finds that proximity and common language/colonial ties are more important for trade in differentiated products than for trade in homogeneous goods. This fits his

hypothesis that search barriers to trade are higher for differentiated products, which allows buyer-seller relationships to play a more important role in trade in differentiated goods.

Theoretical work that links network effects to international trade includes Rauch (1996), McLaren (1999) and Casella and Rauch (2002). Rauch (1996) adapts a search model from labor economics to describe trade in differentiated products. Government-sponsored export promotion policies (e.g., trade missions) and Japan's general trading companies (*sogo shosha*) can be explained as means of economizing on these search costs across firms. McLaren (1999) examines the differences between contractual and noncontractual (or relational) industrial procurement, comparing methods typically associated with Western versus Japanese firms. He builds a model that predicts that the latter will become more prevalent over time as the costs of international transactions fall. For this paper, the most relevant theoretical work is Spencer and Qiu (2001). They model the vertical long-term relationships that exist in Japanese automobile *keiretsu* and examine the effect of these relationships on US-Japan trade in auto parts. Their model helps to explain US-Japan trade friction in this sector resulting from asymmetric information regarding investment rents generated by long-term buyer-supplier relationships.

This paper adds to the theoretical literature on this topic by examining the impact of business and social networks on international trade. The paper also is the first to consider how networks affect foreign direct investment (FDI). A model of multi-product firms with asymmetric network effects produces the possibility of an asymmetric equilibrium in which the firm from the country with stronger network effects (the home country) invests abroad while the foreign firm does not. The home firm's foreign affiliate then exports back to its home market, sometimes selling more than the foreign firm does through its exports from the same production

location. The home firm's affiliate also sells more in the foreign market than the foreign firm sells (on a per-variety basis) in its own market.

Network effects are modeled as a variable cost disadvantage faced by the foreign firm selling in the home market, regardless of the foreign firm's production location. Business networks may make entry into a particular market more difficult, both for exporters and for foreign investors. The cost reflects the resource expenditure needed to compensate for the lack of a pre-existing relationship with buyers. This relationship is based on the historical, cultural and/or language ties that exist between buyers and sellers from the same country. The cost also may reflect strategic choices made by these agents in the past. Relationship-specific investments have been examined by Spencer and Qiu (2001) and by many others as a way of explaining long-term buyer-supplier relationships within *keiretsu* groups in Japan.⁴ My model is a similar attempt to incorporate linkages between buyers and sellers into a model of international trade, but I focus on the trade and FDI decisions of firms rather than on the trade and relationship-specific investment decisions made by buyers and parts suppliers.⁵

My model is particularly useful in explaining asymmetries in US-Japan bilateral trade and FDI that have led to trade friction in recent years. Data on these asymmetric flows is presented in the next section.

2. Stylized Facts on US-Japan Trade and FDI Asymmetries

Trade friction between the US and Japan often is linked to asymmetric trade and investment flows. Japanese firms both invest more in and export more to the US. Japan's average annual bilateral merchandise trade surplus with the US was \$72.9 billion and the average annual bilateral FDI deficit was \$4.6 billion for 1998-2000.⁶ The trade and investment imbalance is particularly large in the automotive sector. Japan's bilateral trade surplus with the

US in SITC 781 (autos) and 784 (auto parts) in 1998 was \$28.6 billion.⁷ Four of Japan's major auto producers have solely-owned auto production facilities in the US (Honda, Mitsubishi, Nissan and Toyota) and three others (Isuzu, Fuji and Mazda) plus Toyota have joint venture auto plants there. American auto producers have no solely-owned production plants in Japan, but they have increased their equity holdings in Japanese producers over the past 5 years.⁸ These trade and FDI imbalances imply strong competitive pressures on US firms in their home market.

The larger presence of Japanese affiliates in the US leads to larger flows of reverse imports from the US to Japan than vice versus. Nonbank Japanese affiliates in the US sent \$28.4 billion in reverse imports to Japan in 1997.⁹ Nonbank majority-owned American affiliates in Japan reverse imported \$4.1 billion in 1994.¹⁰ Japanese affiliates reverse imported 6.4% of their total sales while US affiliates reverse imported 4.2% in the different years. These numbers show that the tendency to reverse import out of total sales is not very different. What is different, however, is the aggregate volume of reverse imports and the role they play in a country's total imports. Reverse imports accounted for 51.2% of Japan's total imports from the US in 1987 and 39.8% in 1997, while reverse imports accounted for only 3.4% of US imports from Japan in 1994. This wide gap is apparent not only in comparing Japanese affiliates in America to American affiliates in Japan, but also in comparing the former to third-country affiliates in America. The almost 40% share of Japan's total bilateral imports held by reverse imports from Japanese affiliates in the US in 1997 is much higher than the 0.5% to 13.6% range for affiliates of firms from other industrialized countries.¹¹ I propose that these differences stem at least partially from asymmetric network effects. That is, relationships between buyers and sellers matter more in Japan, so Japanese firms have a stronger advantage in selling in their home market.

Some of the asymmetries in US-Japan bilateral sectoral trade and FDI flows may be explained by differences in market size and investment costs. Simply put, the US market is larger and average real estate prices lower than in Japan. The former leads to larger US imports and both lead to larger inflows of direct investment into the US. However, these market differences cannot explain why a Japanese affiliate in the US might export more back to Japan than a US competitor exports to Japan.¹² To explain the advantage that Japanese firms appear to have in making sales to Japanese consumers and to other Japanese firms, I turn to network effects. Other alternative hypotheses are discussed in the paper's conclusion.

The next section describes the basic model, which follows Baldwin and Ottaviano's (2001) model of reciprocal trade and FDI by multi-product multinationals. Baldwin and Ottaviano (hereafter referred to as B&O) develop a model to describe two-way flows of FDI across developed countries in a single industry. In their model with complete symmetry across countries, an asymmetric equilibrium with a one-way flow of FDI is never an equilibrium outcome. To describe asymmetries in US-Japan FDI flows, I introduce asymmetric network effects to the basic model and analyze the resulting equilibria in the subsequent section, followed by concluding comments.

3. The Basic Model

Until network costs are introduced, the model and notation follow those in B&O.¹³ Assume a two-country (home and foreign), two-sector (X and Z) world where the X sector is characterized by imperfect competition and the Z sector by perfect competition. Each country is endowed with L units of labor and has one producer in the X sector producing differentiated products with costs $w(F + a_x x)$ per variety, where w is the wage, F is the fixed cost, a_x is the variable cost and x is output. Each firm may choose to locate production of a variety abroad by

incurring an additional fixed cost, Γ , which represents the cost of multinationality (i.e., $\Gamma > 0$).

Each variety is produced in a single plant located in either the home or foreign country.

In period one, firms decide whether to locate production of a variety abroad or not. In period two, firms make output decisions. The equilibrium concept is subgame perfect Nash and the Pareto refinement is used in cases of multiple equilibria. Firms may export their varieties to the foreign market by paying a per unit trade cost, t , $t > 0$. This trade cost covers transportation costs and any existing trade barriers. Markets are assumed to be segmented. To maintain tractability in the model, I assume each firm produces only two varieties.¹⁴ The home firm produces varieties 1 and 2, the foreign firm produces varieties 3 and 4.

The Z good is produced with cost function wa_zZ , where a_z is the unit input coefficient. Units are chosen such that $a_z=1$, and L serves as numeraire so the price of Z is unity.

Consumer preferences in each country are defined by the following utility function:

$$(1) \quad U = Z + U_x = Z + \sum_{i=1}^4 (ax_i + x_i^2 / 2) - bx_1x_2 - bx_3x_4 - x_1(cx_3 + dx_4) - x_2(cx_4 + dx_3).$$

All of the X varieties are substitutes, so product substitutability parameters b , c and d are positive. The following parameter restrictions are necessary and sufficient for a concave utility function: $a > 0$, $b < 1$, $c - d < 1 - b$, $d - c < 1 - b$, $c + d < 1 + b$. The inverse demand functions derived from utility maximization are:

$$(2) \quad \begin{aligned} p_{1j} &= a - x_{1j} - bx_{2j} - cx_{3j} - dx_{4j}; & p_{2j} &= a - x_{2j} - bx_{1j} - cx_{4j} - dx_{3j}; \\ p_{3j} &= a - x_{3j} - bx_{4j} - cx_{1j} - dx_{2j}; & p_{4j} &= a - x_{4j} - bx_{3j} - cx_{2j} - dx_{1j}; \end{aligned}$$

where p_{ij} is the price of variety i in market j ($j=h,f$). The linear inverse demand functions allow me to assume $a_x=0$ without loss of generality.

4. Introducing Network Effects

Network effects are introduced in the model in the form of an additional per unit cost, n , that the foreign firm must pay in order to sell its product in the home market regardless of the foreign firm's production location.¹⁵ This added cost for the foreign firm of doing business in the home market differs from traditional trade barriers that are imposed at the border. In other words, the cost cannot be avoided by direct investment in the home country. The added cost may reflect search costs involved in locating buyers, distribution costs and/or information costs that are assumed to be higher for "outsiders" in some markets. As was mentioned in the paper's introduction, the home firm's advantage in selling to home buyers may be determined exogenously by the home country's history, geography or culture or it may be determined endogenously by relationship-specific investments made in the past by home buyers and/or sellers.¹⁶

Admittedly, network effects may exist in both markets, giving local firms in either country an advantage in selling to local buyers. My focus, however, is on asymmetric network effects across countries. Therefore, I assume zero network costs in the foreign market and positive network costs in the home market to maintain simplicity while studying the effects of asymmetric costs. The model is solved through backward induction, starting with the period two equilibrium.

4.1 Period Two Equilibrium

In the second period, firms choose their outputs, having already located their production plants in one or both countries. The following cases describe the four possible equilibrium types: the N-type equilibrium where both firms are national firms, the M-type equilibrium where both firms become multinational through reciprocal FDI, and two A-type equilibria in which the firms

make asymmetric choices. The A-type equilibrium solutions are algebraically very lengthy even if I assume the firms have symmetric costs (i.e., $n = 0$). Therefore, to maintain tractability while adding complexity in the form of asymmetric costs, I sacrifice complexity in terms of product variety. For the remainder of the paper, I focus on the case with full symmetry across products (i.e., $b = c = d$).¹⁷

N-type equilibrium with network costs

When both firms are national or N-type firms, they face the following maximization problems in period two:

$$(3) \quad \max \quad p_{1h}x_{1h} + (p_{1f} - t)x_{1f} + p_{2h}x_{2h} + (p_{2f} - t)x_{2f} - 2F ;$$

$$\max \quad p_{3f}x_{3f} + (p_{3h} - t - n)x_{3h} + p_{4f}x_{4f} + (p_{4h} - t - n)x_{4h} - 2F .$$

The foreign firm must pay the network cost, n , on top of the trade cost, t , for each unit of varieties 3 and 4 exported to the home market. Solving these maximization problems produces the following equilibrium outputs:

$$(4) \quad x_{1h}^N = x_{2h}^N = \frac{a + b(n + t)}{2(1 + 2b)} ; \quad x_{3h}^N = x_{4h}^N = \frac{a - (1 + b)(n + t)}{2(1 + 2b)} ;$$

$$(5) \quad x_{1f}^N = x_{2f}^N = \frac{a - (b + 1)t}{2(1 + 2b)} ; \quad x_{3f}^N = x_{4f}^N = \frac{a + bt}{2(1 + 2b)} .$$

With market segmentation, the introduction of network effects in the home market has no impact on equilibrium outputs in the foreign market. Therefore, the equilibrium outputs in the foreign market are the same as in B&O. I assume that the equilibrium quantity of each variety is positive in both markets, which means that the smallest quantity in (4) and (5) must be positive (i.e., $x_{3h}^N, x_{4h}^N > 0$). Therefore, parameters must satisfy $a > (1 + b)(n + t)$. To give the foreign firm the incentive to export to the home market, demand must be sufficiently high (i.e., high a),

products sufficiently differentiated (i.e., low b) and the network and trade costs sufficiently low (i.e., low n and t).

M-type equilibrium with network costs

In the M-type equilibrium, I assume that the home (foreign) firm locates production of variety 2 (4) abroad, without loss of generality. The firms face the following:

$$(6) \quad \max \quad p_{1h}x_{1h} + (p_{1f} - t)x_{1f} + (p_{2h} - t)x_{2h} + p_{2f}x_{2f} - 2F - \Gamma ;$$

$$\max \quad p_{3f}x_{3f} + (p_{3h} - t - n)x_{3h} + (p_{4f} - t)x_{4f} + (p_{4h} - n)x_{4h} - 2F - \Gamma .$$

Profit maximization results in the following equilibrium quantities in the home market:

$$(7) \quad x_{1h}^M = \frac{2a(1-b) + b[2n(1-b) + 3t]}{4(1+2b)(1-b)} ; \quad x_{2h}^M = \frac{2a(1-b) + b[2n(1-b) - t] - 2t}{4(1+2b)(1-b)} ;$$

$$x_{3h}^M = \frac{2a(1-b) - 2n(1-b^2) - t(2+b)}{4(1+2b)(1-b)} ; \quad x_{4h}^M = \frac{2a(1-b) - 2n(1-b^2) + 3bt}{4(1+2b)(1-b)} .$$

These outputs can be ranked with the home firm's home market sales, x_{1h}^M , on top and imports from the foreign firm, x_{3h}^M , on the bottom. In between these high and low outputs fall the home firm's reverse imports, x_{2h}^M , and the foreign firm's sales by its local affiliate, x_{4h}^M .

Interestingly, the former can exceed the latter.

Reverse imports cannot exceed affiliate sales in B&O's basic model with symmetric costs (i.e., $n = 0$) because the symmetry results in only two equilibrium output levels, one level for the two locally-produced varieties and a lower level for the two imported varieties. In this paper's model, asymmetric network costs lead to a different output level for each of the four varieties sold in the home market in the M-type equilibrium. Reverse imports exceed sales by the foreign firm's affiliate if $n(1-b) > t$. High network costs, low substitutability across

products (i.e., a low cannibalization effect¹⁸) and low trade costs boost reverse imports relative to sales by the foreign firm's local affiliate.

The equilibrium outputs in the foreign market are the same as in B&O:

$$(8) \quad x_{2f}^M = x_{3f}^M = \frac{2a(1-b) + 3bt}{4(1+2b)(1-b)}; \quad x_{1f}^M = x_{4f}^M = \frac{2a(1-b) - t(2+b)}{4(1+2b)(1-b)}.$$

Varieties 2 and 3 are produced in the foreign market, while varieties 1 and 4 are produced in the home market for sale in the foreign market. Due to trade costs, the former exceed the latter.

To insure that all equilibrium quantities in the M-type equilibrium are positive, I compare the smallest output levels across markets and find $x_{3h}^M < x_{1f}^M = x_{4f}^M$. The foreign firm exports less to the home market, x_{3h}^M , than the home firm exports to the foreign market, x_{1f}^M , due to the asymmetric network cost. To insure positive equilibrium output of each variety, parameters must satisfy $x_{3h}^M > 0$ or $2a(1-b) - 2n(1-b^2) - t(2+b) > 0$.

A-type equilibria with network effects

Two asymmetric equilibria must be examined, one in which the home firm is the only multinational firm and other in which the foreign firm is the only multinational. With the cost disadvantage faced by the foreign firm, the A-type equilibrium with a multinational foreign firm can be shown to never be subgame perfect so these solutions are not reported here.¹⁹ The A-type equilibrium with a multinational home firm involves the following maximization problems:

$$(9) \quad \max \quad p_{1h}x_{1h} + (p_{1f} - t)x_{1f} + (p_{2h} - t)x_{2h} + p_{2f}x_{2f} - 2F - \Gamma;$$

$$\max \quad p_{3f}x_{3f} + (p_{3h} - t - n)x_{3h} + p_{4f}x_{4f} + (p_{4h} - t - n)x_{4h} - 2F.$$

The home market equilibrium outputs are:

$$(10) \quad x_{1h}^{AM} = \frac{2a(1-b) + b[2n(1-b) + t(4-b)]}{4(1+2b)(1-b)}; \quad x_{2h}^{AM} = \frac{2a(1-b) + b[2n(1-b) - bt] - 2t}{4(1+2b)(1-b)};$$

$$x_{3h}^{AN} = x_{4h}^{AN} = \frac{2a - b(2n + t) - 2(n + t)}{4(1 + 2b)}.$$

The home firm's sales of the home-produced variety (i.e., x_{1h}^{AM}) top the per-variety output ranking, but the ordering of the others depends upon parameter values. While reverse imports always exceed regular imports (on a per-variety basis) in the M-type equilibrium, in the A-type equilibrium this holds only if $2n > bt/(1 - b)$. That is, high network costs, low substitutability across products and low trade costs boost the home firm's reverse imports relative to imports from the foreign firm. Both types of imports are higher in the A-type equilibrium because they do not have to compete with a locally-produced foreign variety, as in the M-type equilibrium. Per-variety imports from the foreign firm increase more than reverse imports in moving from an M-type to an A-type equilibrium because the foreign firm is not cannibalizing its own locally-produced variety by importing in the A-type equilibrium.

With varieties 2, 3 and 4 all produced in the foreign market, the equilibrium outputs in that market are:

$$(11) \quad x_{1f}^{AM} = \frac{2a(1 - b) - t(2 + 2b - b^2)}{4(1 + 2b)(1 - b)}; \quad x_{2f}^{AM} = \frac{2a(1 - b) + bt(2 + b)}{4(1 + 2b)(1 - b)};$$

$$x_{3f}^{AN} = x_{4f}^{AN} = \frac{2a + bt}{4(1 + 2b)}.$$

These foreign market outputs can be ranked as follows: $x_{2f}^{AM} > x_{3f}^{AN} = x_{4f}^{AN} > x_{1f}^{AM}$. This means that sales are highest for the home firm's foreign affiliate, followed by foreign market sales by the foreign firm, and lastly by exports from the home firm to the foreign market. The lower cannibalization effect between the home firm's two varieties after FDI has occurred results in the highest per variety sales for the home firm's overseas affiliate. These output comparisons can be summarized as follows:

Result 1: In the A-type equilibrium with a multinational home firm and a national foreign firm, the home firm has the top-selling variety in both markets. If $2n > bt/(1-b)$, the home firm also has the second-highest-selling variety in its home market through reverse imports from its overseas affiliate.

This result illustrates how asymmetric network effects can lead to asymmetric sales outcomes that favor the firm from the country with stronger network effects. One would expect this firm to sell more of its home-produced variety at home than foreign competitors could sell there. What is somewhat more surprising is that asymmetric FDI decisions can result in an outcome where the home firm's foreign affiliate has the top-selling variety in the foreign market and may have the second-highest-selling variety in its home market.²⁰ After establishing the conditions to insure positive equilibrium outputs in the A-type equilibrium, I compare profits across the various equilibria to see what conditions produce the A-type equilibrium outcome.

To insure positive output of each variety in each market, I compare the lowest values in each market (i.e., x_{2h}^{AM} , x_{3h}^{AN} and x_{1f}^{AM}). It is easy to show $x_{2h}^{AM} > x_{1f}^{AM}$; that is, reverse imports into the home market where only one variety is produced locally exceed imports into the foreign market where three varieties are locally produced. Therefore, parameters must be chosen such that x_{3h}^{AN} and x_{1f}^{AM} are positive (i.e., $2a - b(2n+t) - 2(n+t) > 0$ and $2a(1-b) - t(2+2b-b^2) > 0$).

4.2 Period One Equilibrium

The firms' equilibrium profits in the three possible equilibria²¹ must be compared to determine the parameter range over which each equilibrium is subgame perfect (SGP). For an equilibrium to be SGP, the firms must not have an incentive to deviate to an alternative equilibrium. For example, the M-type equilibrium is SGP if neither firm wants to deviate to an

A-type equilibrium in which it is a national, rather than a multinational firm. That is, the M-type equilibrium is SGP if $\pi_k^M - 2F - \Gamma > \pi_k^{AN} - 2F$ for $k = h, f$ where π_k^M (π_k^{AN}) is the operating profits of firm k in the M-type equilibrium (A-type equilibrium where it is the only national firm). Similarly, the N-type equilibrium is SGP if neither firm wants to deviate by directly investing abroad. Cases of multiple equilibria are handled by determining which equilibrium Pareto dominates (dom) the other(s). By stating that profits in a given equilibrium exceed profits from deviation, the following conditions establish the period one equilibrium:

$$(12) \quad \text{M is SGP: } \pi_h^M - \Gamma > \pi_h^{AN} \text{ and } \pi_f^M - \Gamma > \pi_f^{AN}$$

$$(13) \quad \text{N is SGP: } \pi_h^N > \pi_h^{AM} - \Gamma \text{ and } \pi_f^N > \pi_f^{AM} - \Gamma$$

$$(14) \quad \text{M dom N: } \pi_h^M - \Gamma > \pi_h^N \text{ and } \pi_f^M - \Gamma > \pi_f^N \text{ }^{22}$$

$$(15) \quad \text{A is SGP: } \pi_h^{AM} - \Gamma > \pi_h^N \text{ and } \pi_f^{AN} > \pi_f^M - \Gamma$$

Using the equilibrium profits, the two constraints can be reduced to just one binding constraint for the first three cases above, as follows:

$$(12') \quad \text{M is SGP: } \pi_f^M - \Gamma > \pi_f^{AN}$$

$$(13') \quad \text{N is SGP: } \pi_h^N > \pi_h^{AM} - \Gamma$$

$$(14') \quad \text{M dom N: } \pi_f^M - \Gamma > \pi_f^N$$

The A-type equilibrium is subgame perfect for a bounded range of Γ values (i.e., $(\pi_h^{AM} - \pi_h^N) > \Gamma > (\pi_f^M - \pi_f^{AN})$). The critical values of Γ for the A-type equilibrium are the same as the critical values of Γ for the N- and M-type equilibria. Let $\bar{\Gamma} = (\pi_h^{AM} - \pi_h^N)$ and $\underline{\Gamma} = (\pi_f^M - \pi_f^{AN})$. As long as $\bar{\Gamma} > \underline{\Gamma}$ and $\bar{\Gamma} > 0$, a range of Γ values exists for which the A-type equilibrium is SGP.

Result 2: If $\bar{\Gamma} > \underline{\Gamma}$ and $\bar{\Gamma} > 0$, the A-type equilibrium with an M-type home firm and an N-type foreign firm is the only subgame perfect equilibrium over a range of Γ values bounded by $\max(0, \underline{\Gamma})$ and $\bar{\Gamma}$. The conditions to insure $\bar{\Gamma} > \underline{\Gamma}$ and $\bar{\Gamma} > 0$ are $n > bt$ and $bt(2 + 4b + 3b^2) - 2n(1 - b)(1 + b)^2 > 0$, respectively.

Proof of Result 2 is included in the Appendix. The above conditions imply that the A-type equilibrium can occur when network costs are sufficiently high relative to trade costs and product substitutability, but not so high that the home firm lacks the incentive to invest abroad. Since $b < 1$ by definition, network costs can be lower than trade costs but still satisfy the $n > bt$ condition needed to produce the A-type equilibrium.

Figures 1-3 illustrate the effect that asymmetric network costs have on the equilibrium parameter space. Figure 1 reproduces B&O's Figure 1, showing the equilibrium parameter space when costs are symmetric across the two markets (i.e., $n = 0$) and the boundaries are plotted in $(b, \Gamma/t^2)$ space. As they describe, "Increasing 'b' exacerbates the cannibalisation effect and thus encourages FDI, and the cannibalisation-reducing effect of FDI is magnified by trade costs, t. By raising the cost of separating production, a high Γ has the opposite effect." (B&O, p. 441) The N-type outcome is a Nash equilibrium above the 'N is SGP' line (i.e., in regions 1 and 2) and the M-type outcome is a Nash equilibrium below the 'M is SGP' line (i.e., in regions 2, 3 and 4). In region 2 where both symmetric outcomes are Nash equilibria, the N-type equilibrium Pareto dominates the M-type equilibrium, since the 'M dom N' line lies below the 'N is SGP' line.²³ Therefore, the M-type equilibrium prevails only in regions 3 and 4. In this case with $n = 0$, there is no parameter space where the A-type equilibrium is SGP.

Allowing asymmetric network costs introduces the possibility of an A-type equilibrium, as shown in Figures 2 and 3. To plot the boundaries in two-dimensions, I assume $n = 0.75t$ in Figure 2 and $n = t$ in Figure 3. The ‘N is SGP’ line represents the upper boundary for the A-type equilibrium, $\bar{\Gamma}$, when $t = 1$. The lower boundary, $\underline{\Gamma}$, is represented by the ‘M is SGP’ line when $t = 1$. The A-type equilibrium is the only SGP equilibrium in region 5. The N-type equilibrium prevails in regions 1 and 2 and the M-type equilibrium prevails in regions 3 and 4. Intuitively, it makes sense that if the cost of multinationality, Γ , is very high (or the trade cost, t , is very low) neither firm will choose to invest abroad. In this case, the N-type equilibrium will prevail. As Γ/t^2 decreases it becomes more attractive for the firms to invest abroad. The asymmetry in network costs means that the critical value for investing abroad occurs at a higher value of Γ/t^2 for the home firm than for the foreign firm, thus making the A-type equilibrium possible. For very low Γ/t^2 values, both firms invest abroad so only the M-type equilibrium is SGP.

In Figure 2 with $n = 0.75t$, $b > 0.75$ does not satisfy the condition to insure $\bar{\Gamma} > \underline{\Gamma}$ ($n > bt$), so no A-type equilibrium occurs for $0.75 \leq b < 1$. That is, with low network costs relative to trade costs, strong cannibalization effects (i.e., high b) drive the firms to make symmetric decisions regarding FDI. With higher network costs illustrated in Figure 3 (i.e., $n = t$), the A-type equilibrium is possible over the entire range of values of ‘ b ’, the product differentiation parameter.

Comparing across the three figures illustrates a positive relationship between the level of network costs and the range of parameter values that produce an A-type equilibrium. The higher the network costs, the greater the asymmetry between firms and therefore the greater the potential for an asymmetric equilibrium.

4.3 Profits

By definition the A-type equilibrium gives each firm higher profits than it could achieve by deviating in making its own FDI decision (see equation (15)). In the A-type equilibrium, the home firm earns higher profits than it would in an N-type equilibrium and the foreign firm earns higher profits than in an M-type equilibrium. Although a firm cannot control its rival's strategic choice, it does have a preference over its rival's behavior. This preference may provide insights into the lobbying behavior of the firms. Equilibrium profits can be used to show the following:

Result 3: The home firm prefers an asymmetric equilibrium in which it is the only multinational firm to a symmetric outcome with two multinational firms. The foreign firm prefers an outcome in which neither firm is multinational to the asymmetric equilibrium where its rival is a multinational firm.

Proof of Result 3 is included in the Appendix. Result 3 establishes the context for trade friction to arise in the differentiated product sector. In cases where an M-type equilibrium would occur otherwise (i.e., for $0 < \Gamma < \underline{\Gamma}$), the home firm has an incentive to block this outcome by preventing FDI inflow into its market as long as it intends to invest abroad (i.e., for $\Gamma < \bar{\Gamma}$). The foreign firm has an incentive to prevent FDI inflow into its market whenever an A-type equilibrium would occur otherwise (for $\underline{\Gamma} < \Gamma < \bar{\Gamma}$). Although my model does not provide a context in which firms can strategically deter entry into their domestic markets, Result 3 suggest that they might like to do so if they could. The firms could prevent FDI inflows by raising the cost of direct investment in their particular market (i.e., raising a market-specific version of Γ). The home firm also could accomplish this goal by raising network costs, n .

4.4 Reverse Imports

The model allows for comparisons of reverse imports and regular imports across different equilibria. The stylized facts mentioned earlier show much larger flows of reverse imports from the US to Japan than vice versus. They also show Japan's reverse imports as a share of total bilateral imports to be much higher than that for the US or for other developed countries with affiliates in the US. Simple comparisons of equilibrium outputs shown above match these stylized facts as follows:

Result 4: In the M-type equilibrium, the home country's reverse imports exceed the foreign country's reverse imports due to the asymmetric network costs. In this equilibrium, the home country's reverse imports exceed regular imports. This result holds true in the A-type equilibrium as well if $2n > bt/(1-b)$.

Result 5: In the M-type equilibrium, reverse imports account for a higher share of total imports for the home country than for the foreign country due to the asymmetric network costs.

The share of reverse imports in total imports for the foreign country is $\frac{1}{2}$. For the home country where $n > 0$, reverse imports exceed regular imports, as stated previously, so the share of total imports held by reverse imports exceeds $\frac{1}{2}$.

4.5 Sales

To develop some intuition regarding the impact of network effects on consumer welfare, I examine the impact on total sales in each equilibrium.²⁴ These quantities are as follows:

$$(16) \quad \sum_{i=1}^4 x_{ih}^N = \sum_{i=1}^4 x_{ih}^M = \frac{2a - n - t}{1 + 2b};$$

$$(17) \quad \sum_{i=1}^4 x_{if}^N = \sum_{i=1}^4 x_{if}^M = \frac{2a - t}{1 + 2b};$$

$$(18) \quad \sum_{i=1}^4 x_{ih}^{Aj} = \frac{4a - 2n - 3t}{2 + 4b};$$

$$(19) \quad \sum_{i=1}^4 x_{if}^{Aj} = \frac{4a - t}{2 + 4b}; \quad j=M \text{ for } i=1,2 \text{ and } j=N \text{ for } i=3,4.$$

In the N- and M-type equilibria, two varieties are produced in each market and two varieties are imported. As shown in (16) and (17), the total sales across these two equilibria are the same for the home market and for the foreign market. Due to network costs, the total sales in the foreign market exceed those in the home market by $n/(1 + 2b)$. In the A-type equilibrium, sales in the foreign market exceed those in the home market by an even larger value, $(n + t)/(1 + 2b)$, because three varieties are produced in the foreign market in this case versus only one produced in the home market.

Comparing across equilibria, sales in the home market are lower in the A-type equilibrium than in either N- or M-type equilibrium because fewer varieties are produced locally (i.e., one versus two locally-produced varieties). Sales are highest in the foreign market with three varieties produced there in the A-type equilibrium relative to the other two equilibrium types. Despite these country-level differences across equilibria, the worldwide (i.e., two-country) sales are the same in each equilibrium and equal to $(4a - n - 2t)/(1 + 2b)$. Network costs in the home country cause a decrease in worldwide sales of $n/(1 + 2b)$, with all of this decrease suffered by the home country in the N and M-type equilibria, and an even larger decrease (and corresponding increase for the foreign country) in the A-type equilibrium.

4.6 Trade Displacement

B&O use a ‘trade displacement metric’ (TDM) to capture the change in bilateral sectoral trade of the differentiated product in switching from an equilibrium with N-type firms to one with M-type firms. Since my model has more than one alternative to the N-type equilibrium, I

calculate several displacement metrics. The TDM^{ij} captures the change in bilateral sectoral trade in switching from the i-type equilibrium to the j-type equilibrium. Using the traded quantities in (4), (5), (7), (8), (10) and (11), the TDM's in my model are:

$$(23) \quad TDM^{NM} = \frac{2bt - n(1-b)}{2(1-b)} = \frac{bt}{(1-b)} - \frac{n}{2};$$

$$(24) \quad TDM^{NA} = \frac{b(3bt - n(1-b))}{2(1-b)(1+2b)};$$

$$(25) \quad TDM^{AM} = \frac{bt(2+b) - n(1-b^2)}{2(1-b)(1+2b)}.$$

For $n = 0$, TDM^{NM} matches that in B&O and is positive, indicating that trade declines when firms switch from N-type to M-type. That is, reciprocal FDI displaces some, but not all, trade as long as products are imperfect substitutes (i.e., $b < 1$).²⁵ The other two metrics, TDM^{NA} and TDM^{AM} , also are positive for $n = 0$. The equations in (23) through (25) make it quite apparent that all of the TDM's are decreasing in n . What is not readily apparent, but is proven in the Appendix, is that the TDM's remain positive over the range of parameters that allow for each equilibrium. This result can be stated as follows:

Result 6: Asymmetric network costs lower, but do not completely eliminate, the trade displacement that results from one-way or reciprocal FDI.

This result will help in interpreting the effect of network costs on consumer welfare since trade displacement represents an efficiency improvement through the elimination of trade costs.

4.7 Consumer Welfare

Consumer welfare is calculated by substituting equilibrium quantities into the utility function in (1).²⁶ Unfortunately, the algebraic complexity introduced by asymmetric costs make it impossible to strictly sign welfare comparisons across equilibria in most cases. Instead, I

compare consumer welfare by assigning parameter values that allow for the possibility of an A-type equilibrium and that satisfy the restrictions mentioned previously (i.e., to insure a concave utility function and positive sales of each variety in each market.)

Table 1 shows equilibrium consumer welfare using four sets of parameter values. Cases 1-3 illustrate the effect of varying the network cost, n , and cases 2 and 4 show the outcomes with different levels of product differentiation, b . The Γ range is created using the conditions stated in Result 2 for establishing the existence of the A-type equilibrium. The lower bound is $\max[\underline{\Gamma}, 0]$ and the upper bound is $\bar{\Gamma}$. If $\underline{\Gamma} > 0$, the M-type equilibrium prevails for $0 < \Gamma < \underline{\Gamma}$. For $\Gamma > \bar{\Gamma}$, the N-type equilibrium occurs. As shown in Table 1, the parameters chosen in cases 1 and 2 allow for all three equilibrium types as Γ increases from zero, but those chosen in cases 3 and 4 never produce the M-type equilibrium (i.e., $\underline{\Gamma} < 0$). When $\Gamma = 0$, the latter two cases fall within regions 1 and 5 in Figures 2 and 3. When the network cost, n , is sufficiently high and/or when product substitutability, b , is sufficiently low, the foreign firm never chooses to invest abroad.

The shaded cells in Table 1 show the preferred outcomes over the Γ range that results in an A-type equilibrium (i.e., $\underline{\Gamma} < \Gamma < \bar{\Gamma}$). Although algebraic complexity preclude generalizing these results, the consistency of the equilibrium rankings in these simulations is appealing. In every case, home consumers' utility is lowest in the A-type equilibrium and highest in the N-type equilibrium over this Γ range. In other words, home consumers would prefer to not allow a one-way outflow of FDI from their country. This makes sense since they pay the costs of importing three, rather than two, varieties in the asymmetric equilibrium. In Case 1, for very low values of Γ ($0 < \Gamma < 0.094$) the home consumers prefer the M-type equilibrium that will occur, but for higher values that will produce the M-type equilibrium ($0.094 < \Gamma < \bar{\Gamma} = 0.3$), the home

consumers would be better off with neither inflows nor outflows of FDI. This simulation result can be generalized by examining the gap between U_h^M and U_h^N .

$$(26) \quad U_h^M - U_h^N = \frac{t(2n(-3 + 2b + b^2) + bt(2 + b))}{8(1 - b)} - \Gamma.$$

The difference in (26) is decreasing in n since $b < 1$ implies $(-3 + 2b + b^2) < 0$. Increasing the network cost lowers the $U_h^M - U_h^N$ line so that it eventually falls below the ‘N is SGP’ line. This implies that consumers do not always gain from a switch from the N-type to the M-type equilibrium.

Result 7: In contrast to B&O’s results showing that consumers are better off with reciprocal FDI whenever it occurs, asymmetric network costs introduce the possibility that consumers in the country with strong network effects lose from reciprocal FDI.

Consumers in the home country gain from reciprocal FDI only when the cost of multinationality and the network cost are sufficiently low. Network costs lower the gains from reciprocal FDI by lowering the amount of trade displacement resulting from FDI. Lower trade displacement means lower efficiency gains to be shared between the two firms, foreign consumers and home consumers.

As shown in Table 1, the foreign country’s consumer welfare is always highest in the A-type equilibrium as the recipient of one-way FDI. Consumers gain by having three varieties locally produced. This means that for cases where the M-type equilibrium would occur (i.e., $0 < \Gamma < \underline{\Gamma}$), foreign consumers have an incentive to discourage the outflow of FDI. For cases where the N-type equilibrium would occur (i.e., $\Gamma > \bar{\Gamma}$), foreign consumers have an incentive to encourage the inflow of FDI. Since network costs are zero in the foreign country, B&O’s result

that consumers are better off with reciprocal FDI is seen in the simulation results and can be easily proven (i.e., $U_f^M > U_f^N$ for $\Gamma < \underline{\Gamma}$).

5. Conclusions

This paper generalizes Baldwin and Ottaviano's (2001) analysis of reciprocal FDI and trade by allowing for asymmetric outcomes. I introduce asymmetries in the importance of network effects across countries to explain asymmetric flows of trade and FDI at the industry level. As modeled, stronger network linkages between home buyers and sellers give the home firm a variable cost advantage in selling a differentiated product to home market buyers. The asymmetric network cost introduces the possibility of an asymmetric equilibrium with a multinational home firm and a national foreign firm. Even when the two firms make symmetric FDI decisions (i.e., both are national firms or both are multinational firms), asymmetric network costs lead to asymmetric output decisions by the firms and therefore asymmetric trade flows.

The model's predictions fit some of the observed trade and investment asymmetries between the US and Japan. Higher network costs in the Japanese market may lead to an asymmetric equilibrium with a one-way flow of FDI from Japan to the US in a given industry. In this equilibrium, the Japanese firm has the top-selling variety in both markets, and it may have the second-highest-selling variety in its home market through reverse imports from its US affiliate. In this case, the asymmetric network effects have caused asymmetry in both trade and investment flows. The Japanese firm is satisfied with the asymmetric status quo, as are American consumers. The US firm, however, would prefer an equilibrium with no inflow of FDI into its market. Japanese consumers also are not satisfied with the status quo and have an incentive to try to prevent FDI outflows in most cases. If network costs and the cost of multinationality are sufficiently low, however, Japanese consumers may prefer to promote FDI

inflows. Existing import promotion policies in Japan may benefit Japanese consumers (including firms purchasing inputs) by compensating for high network costs. As described in Greaney (2001), these policies lower the fixed cost of investing in Japan's market or lower the network costs of "finding" buyers (e.g., by sponsoring import trade fairs to introduce foreign sellers to Japanese buyers).

Even in equilibria where firms make symmetric FDI decisions, asymmetric network effects help to explain asymmetric trade flows. When both firms invest abroad, Japan's reverse imports exceeds America's reverse imports. Japan's reverse imports also exceed its imports from the American firm, while America's reverse imports matches its imports from the Japanese firm. The latter result helps to explain the observation that reverse imports account for a much larger share of Japan's total imports than they do for other industrialized countries.

This paper's networks-based explanation certainly cannot account for all asymmetric outcomes in US-Japan trade and FDI at the industry level. Alternative explanations, such as comparative advantage, trade barriers and outsourcing, play a role in many sectors.²⁷ Baldwin and Ottaviano (2001) discuss the contribution of their model as providing an explanation for the observed complementarity between FDI and trade at the product level,²⁸ using examples of trade mainly between European countries. This complementarity is difficult to explain with existing models of multinational behavior. The added-value provided in this paper is incorporating asymmetric network effects that lead to asymmetric outcomes and the possibility of trade friction. Existing models of multinationals cannot explain the observation that Honda and Toyota export autos to the US, produce cars in the US and export some of these back to Japan, often exporting more to Japan than their American competitors. Network effects help to explain the advantage that Japanese firms appear to have in making sales to Japanese consumers and to

other Japanese firms. A question left for further research is to what extent network effects can be endogenously determined either by firms or governments and to what extent they are exogenously endowed by a country's history, geography or culture. Also left for future research are questions as to the efficiency advantages that may come from networks or long-term buyer-supplier relationships. My model only examines the disadvantage faced by those "outside" the network; it does not consider that the network itself may generate efficiency advantages through repeated trading or relationship-specific investment.

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¹ The research papers for a 1996 conference on this topic were published in the *Journal of International Economics* in 1999, with an introduction provided by Rauch and Feenstra (1999).

² See Fung (1991) and Lawrence (1991) on *keiretsu* and Rauch and Trindade (1999) on overseas Chinese networks.

³ During the Structural Impediments Initiatives (SII) Talks between the US and Japan in 1989, US negotiators complained that *keiretsu* served to limit foreign access to the Japanese market. However, Sheard (1992) examined arguments regarding the anti-competitive nature of *keiretsu* groups and concluded that there is nothing inherently anti-competitive in the *keiretsu* structure.

⁴ See, for example, Aoki (1988) and Asanuma (1989).

⁵ In Spencer and Qiu (2001), trade and the advantages of network linkages are endogenous while production location is exogenous. In my model, trade and production location are endogenous while network effects are exogenous.

⁶ Trade and FDI balance data are from the US Department of Commerce, Bureau of Economic Analysis website.

⁷ Statistics Canada (1998).

⁸ See Japan Automobile Manufacturers Association (2001) for details.

⁹ Bureau of Economic Analysis (BEA) (2000).

¹⁰ BEA (1998). This survey and BEA (2000) are conducted only once every five years and in differing years so matching-year data is not available. The surveys also differ in reporting reverse imports either by all nonbank affiliates or by majority-owned nonbank affiliates.

¹¹ The BEA (2000) data allow one to match affiliates' country of ultimate beneficial owner to their export destinations only for the following seven countries, along with Japan: Australia, Canada, France, Germany, the Netherlands, Switzerland and the UK.

¹² For example, in the contentious automotive sector, Japanese affiliates in the US exported more to Japan than the US Big Three between 1991 and 1996, according to data on new import car registrations (Japan Automobile Manufacturers Association, 1999).

¹³ The reader is referred to B&O for future justification for the basic model's assumptions.

¹⁴ An earlier version of B&O, Baldwin and Ottaviano (1998), allows firms to produce a continuum of varieties.

¹⁵ Alternatively, I could assume that network effects take the form of an added fixed cost of investing in the home market. In other words, it costs more to become a "local" producer in this market, but once a firm has made this investment, it faces no additional hurdles in doing business there. This type of assumption would allow for an asymmetric equilibrium in terms of the FDI decision made by firms, but it would not generate asymmetric output decisions by firms. Both types of asymmetries are useful for explaining the importance of reverse importing for Japan's total imports.

¹⁶ Greaney (1997) and Greaney (2000) present alternative ways of modeling a home firm's advantages in selling at home. In the former, differences in preferences across countries and informational asymmetries in observing local preferences provide a source of proximity advantage for multinational activity. In the latter, home firms gain lasting advantages from past trade protection when buyer switching costs exist.

¹⁷ B&O consider three cases in their paper, full symmetry ($b = c = d$), firm-wise symmetry ($b > c = d$) and matching product lines ($c > b = d$), but most of their results rely on the algebraic simplicity afforded by the full symmetry assumption.

¹⁸ The "cannibalization effect" refers to negative cross-variety effects experienced by multiproduct firms. Sales of a new variety increase revenues from that variety but decrease revenues from a firm's other varieties. (Brander and Eaton, 1984)

¹⁹ See the Appendix for solutions and proof that an A-type equilibrium with a multinational foreign firm is never subgame perfect.

²⁰ An example of this type of equilibrium might be Honda's or Toyota's competition with any of the Big Three American auto producers. Both Japanese producers have production facilities in the US while the US producers do not produce their cars in Japan (although they do have equity positions in several Japanese auto producers). In recent years, Toyota's Camry or Honda's Accord has often topped the list of best-selling cars in the US, competing with Ford's Taurus for that distinction. From 1991-1997, Honda exported more cars from the US to Japan than any of the Big Three, and in 1995 Toyota did the same.

²¹ Equilibrium profits are shown in the Appendix.

²² Symmetry in the B&O model results in a single condition for (16)-(18) since $\pi_h^k = \pi_f^k$ where $k = N, M, AN, AM$.

²³ B&O prove this ordering of the boundary lines.

²⁴ A comparison of equilibrium prices, as in B&O, is uninformative because the algebraic complexity introduced by asymmetric costs precludes ranking products by price in most cases.

²⁵ This is result 4 in B&O.

²⁶ I follow B&O's method of calculating the consumption of the Walrasian good Z as:

$Z = L - 2F - t(\text{imports})$. Production of X is assumed to be costless, after fixed costs are paid, but importing X uses up t units of domestic L per imported unit. For the home country, network effects use up n units of domestic L per unit purchased from the foreign firm, so $n(x_{3h}^j + x_{4h}^j)$ also is subtracted from L to calculate Z consumption. For a country with a multinational firm, Γ also is subtracted to calculate Z consumption.

²⁷ For example, Japanese FDI in the US in the auto sector was motivated in large part by voluntary export restraints imposed in the 1980's.

²⁸ Allowing product fragmentation provides an alternative explanation for trade and FDI complementarity. That is, FDI in intermediate goods may lead to two-way trade flows in these goods and final products.

Appendix

Equilibrium Profits

Given the equilibrium outputs shown in (4) and (5), the equilibrium operating profits for the N-type equilibrium are:

$$(A1) \quad \pi_h^N = \frac{(1+b) \left[2a^2 + 2a(bn-t) + b^2(n^2 + 2nt + 2t^2) + t^2(1+2b) \right]}{2(1+2b)^2};$$

$$(A2) \quad \pi_f^N = \frac{(1+b) \left[2a^2 - 2a(bn+n+t) + n(1+b)^2(n+2t) + t^2(1+2b+2b^2) \right]}{2(1+2b)^2}.$$

Equilibrium profits in this equilibrium for each firm are the operating profits less $2F$, the fixed cost of producing two varieties.

In the M-type equilibrium, operating profits are:

$$(A3) \quad \pi_h^M = \frac{(1-b^2) \left[4a^2 + 4a(bn-t) \right] - 2b^4n^2 + 2b^3nt + b^2(2n^2 + 3t^2) - 2bt(n-2t) + 2t^2}{4(1+2b)^2(1-b)};$$

$$(A4) \quad \pi_f^M = \frac{(1-b^2) \left[4a^2 + 2(1+b)^2n^2 + 2(1+b)nt - 4a(bn+n+t) \right] + t^2(2+4b+3b^2)}{4(1+2b)^2(1-b)}.$$

Operating profits less $(2F + \Gamma)$ give total profits for the firms in the M-type equilibrium.

The equilibrium operating profits for the A-type equilibrium with a multinational home firm are:

$$(A5) \quad \pi_h^{AM} = \{ (1-b^2) \left[4a^2 + 4a(bn-t) \right] - b^4(2n^2 + 2nt + t^2) + 2b^3nt + 2b^2(n^2 + nt + 2t^2) - 2bt(n-2t) + 2t^2 \} / \{ 4(1+2b)^2(1-b) \};$$

$$(A6) \quad \pi_f^{AN} = \frac{(1+b) \left[4a^2 + 2n^2(1+b)^2 + 2nt(2+3b+b^2) + t^2(2+2b+b^2) - 4a(bn+n+t) \right]}{4(1+2b)^2}.$$

For the M-type home firm, operating profits less $(2F + \Gamma)$ give total profits. For the N-type foreign firm, operating profits less $2F$ give total profits.

A-type Equilibrium with a Multinational Foreign Firm

The other type of asymmetric equilibrium, one in which the home firm is N-type and the foreign firm is M-type, is SGP if: $\pi_h^{AN} > \pi_h^M - \Gamma$ and $\pi_f^{AM} - \Gamma > \pi_f^N$. This A-type equilibrium with a multinational foreign firm can be ruled out if: $(\pi_h^M + \pi_f^N) - (\pi_h^{AN} + \pi_f^{AM}) > 0$. Using equilibrium profits shown above, $(\pi_h^M + \pi_f^N) - (\pi_h^{AN} + \pi_f^{AM}) = \left((1+b)^2 t(n+bt) \right) / \left(2(1+2b)^2 \right) > 0$.

Proof of Result 2

Using the conditions for the A-type equilibrium to be SGP and the equilibrium profits shown above:

$$(A7) \quad \bar{\Gamma} - \underline{\Gamma} = (\pi_h^{AM} - \pi_h^N) - (\pi_f^M - \pi_f^{AN}) = \frac{(1+b)^2 t(n-bt)}{2(1+2b)^2}; \text{ and}$$

$$(A8) \quad \bar{\Gamma} = \frac{bt(bt(2+4b+3b^2) - 2n(1-b)(1+b)^2)}{4(1-b)(1+2b)^2}.$$

When $n > bt$, the difference in (A7) is positive which establishes a range of values for Γ that will produce the A-type equilibrium. The expression in (A8) also must be positive to insure that the range of Γ values includes (at least some) positive values. Since the denominator in (A8) is positive, I need $bt(2+4b+3b^2) - 2n(1-b)(1+b)^2 > 0$ to insure $\bar{\Gamma} > 0$. This difference is positive for $n = bt$, but it may fall below zero for high values of n or low values of t that satisfy the $n > bt$ condition.ⁱ Therefore, the expressions in both (A7) and (A8) must be positive to insure the existence of an A-type equilibrium.

Proof of Result 3

Using the profit solutions shown above,

$$(A9) \quad \pi_h^{AM} - \pi_h^M = \frac{b^2 t(1+b)(2n+t)}{4(1+2b)^2} > 0;$$

$$(A10) \quad \pi_f^N - \pi_f^{AN} = \frac{bt(1+b)(2n(1+b)+t(2+3b))}{4(1+2b)^2} > 0.$$

These inequalities show that the home firm always prefers the A-type equilibrium to the M-type equilibrium and the foreign firm always prefers the N-type equilibrium to the A-type equilibrium.

Proof of Result 6

Using (23), (24) and (25), $TDM^{NM} > 0$, $TDM^{NA} > 0$ and $TDM^{AM} > 0$ when $n < 2bt/(1-b)$, $n < 3bt/(1-b)$ and $n < bt(2+b)/(1-b^2)$, respectively. An M-type equilibrium occurs when $0 < \Gamma < \underline{\Gamma}$, which requires $\underline{\Gamma} > 0$. This puts the following constraint on network costs:

$$(A11) \quad n < \frac{bt(2+4b+2b^2+3b^3)}{2(1-b)(1+b)^3}.$$

This constraint on network costs is more restrictive than the ones listed above for $TDM^{NM} > 0$ and $TDM^{AM} > 0$. Therefore, whenever an M-type equilibrium occurs, trade displacement occurs.

Proving that trade displacement occurs in moving from an N-type to an A-type equilibrium (i.e., $TDM^{NA} > 0$) involves using one of the two conditions needed to insure the existence of an A-type equilibrium. Specifically, we need $\bar{\Gamma} > 0$, which requires $n < bt(2+4b+3b^2)/(2n(1-b)(1+b)^2)$. This condition implies $n < 3bt/(1-b)$ or $TDM^{NA} > 0$.

ⁱ That is, the difference decreases in n and increases in t . The effect of b on this difference cannot be signed.

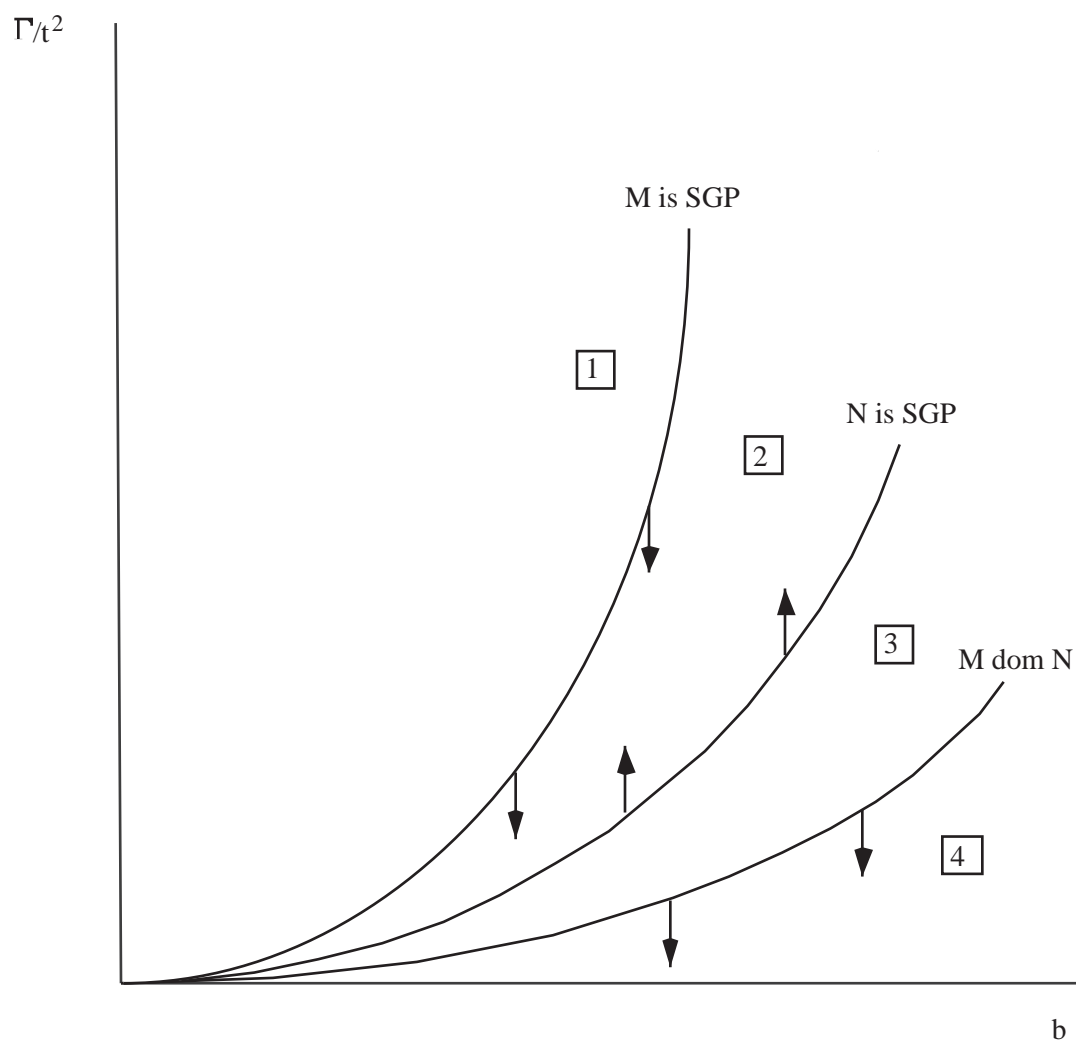


Figure 1. Equilibrium parameter space with $n=0$.

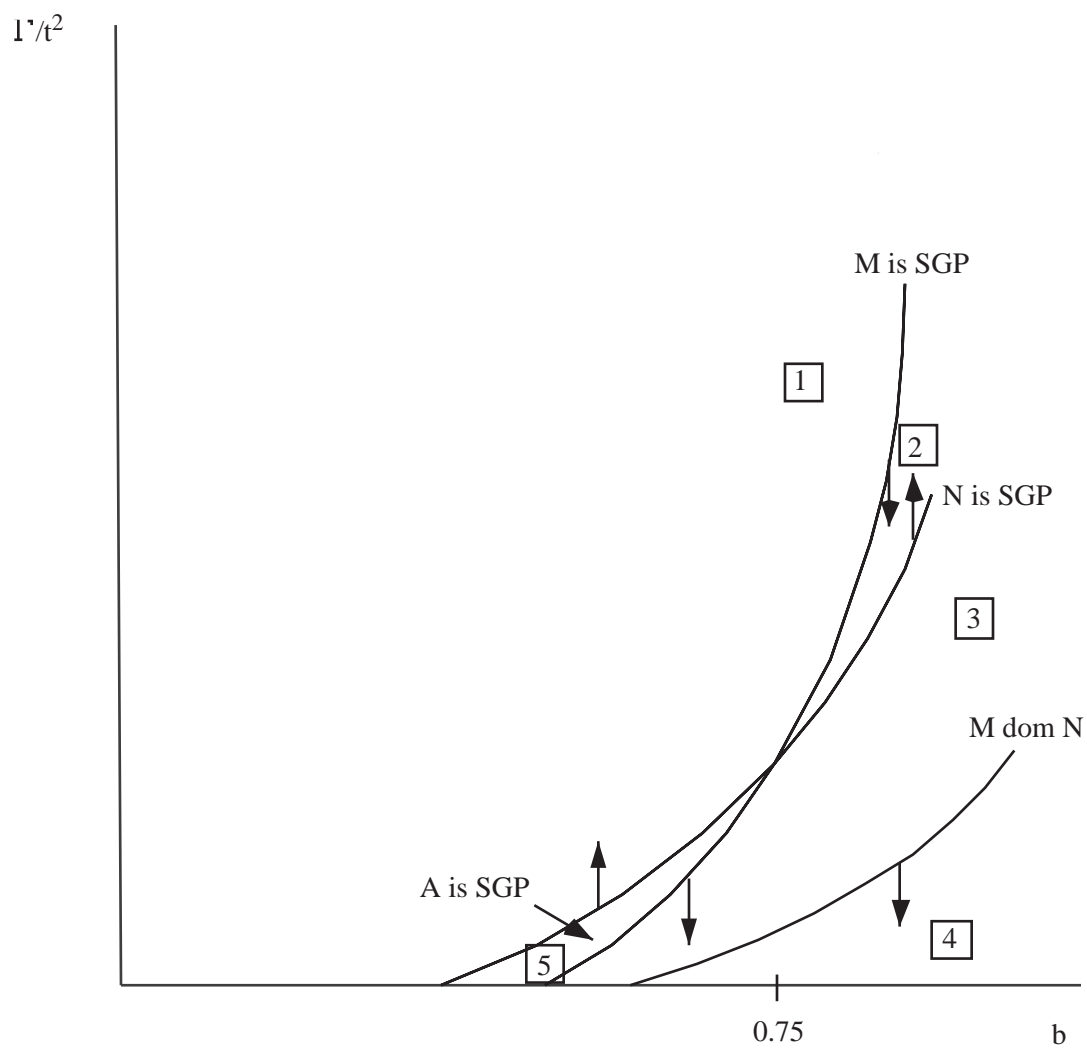


Figure 2. Equilibrium parameter space with $n=0.75t$.

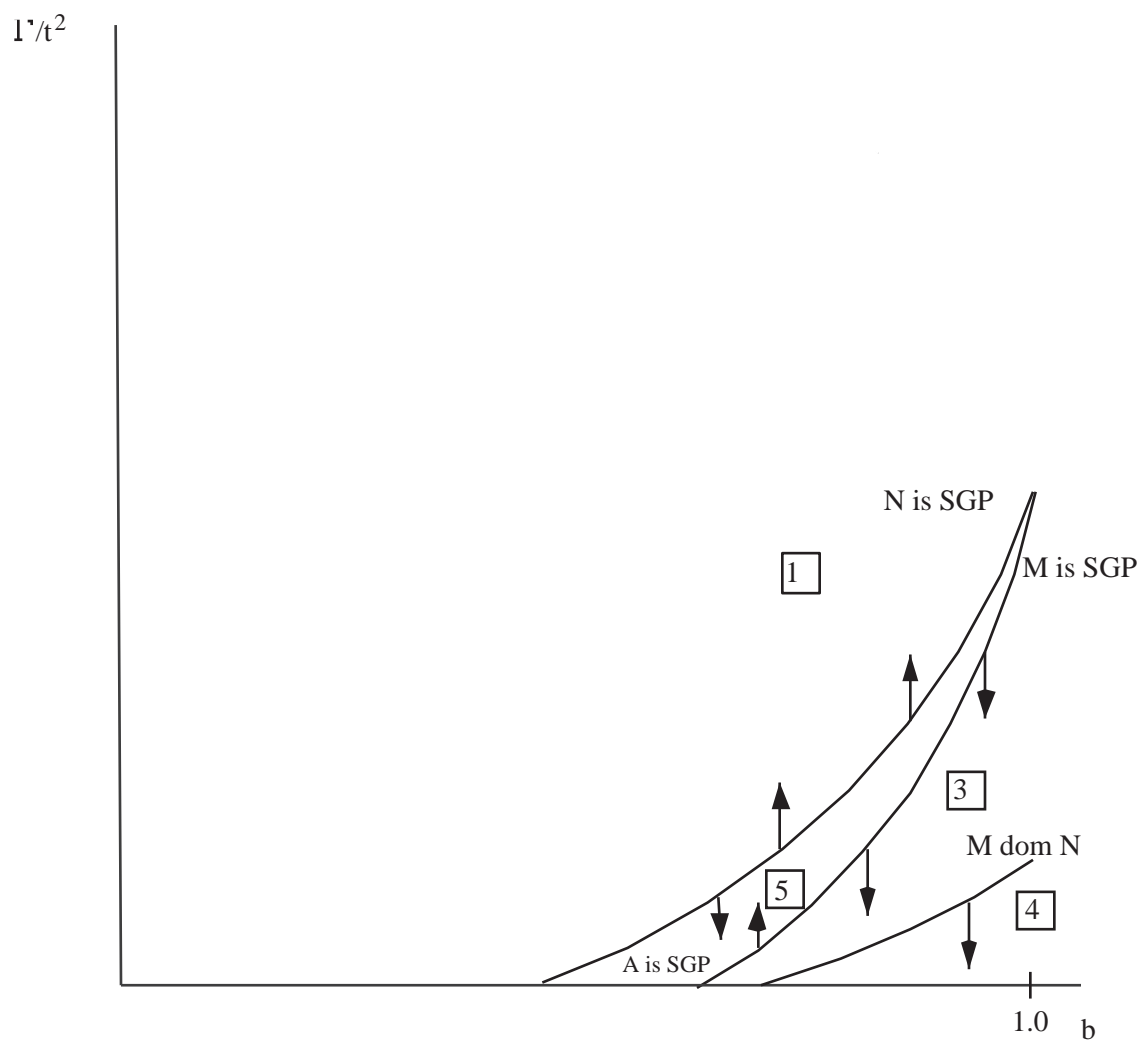


Figure 3. Equilibrium parameter space with $n=t$.

Table 1
Consumer Welfare Comparisons across Different Equilibria

	a	b	n	t	Γ range for A- type eqm. ($\underline{\Gamma}, \bar{\Gamma}$)	U_h^N	U_h^M	U_h^{AM}	U_f^N	U_f^M	U_f^{AN}
Case 1	7	0.7	0.75	1	0.300, 0.313	22.584	22.678- Γ	20.823- Γ	24.302	25.089- Γ	26.449
Case 2	7	0.7	1	1	0.194, 0.269	22.163	22.025- Γ	20.321- Γ	24.302	25.089- Γ	26.449
Case 3	7	0.7	1.5	1	0.0, 0.181	21.546	20.946- Γ	19.543- Γ	24.302	25.089- Γ	26.449
Case 4	7	0.6	1	1	0.0, 0.096	24.114	23.702- Γ	21.975- Γ	26.638	27.126- Γ	28.823

Notes: 1) To accurately calculate all consumer welfare results, each should have $(L - 2F)$ added to it. Since this table is designed to allow comparisons of welfare across equilibria, these common terms are not shown.

2) Shaded cells show the preferred outcome over the Γ range that result in an A-type equilibrium.